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U. S. Department of Justice

Test record

ASCLD/LAB–*International* Testing Accreditation Certificate ALI-217-T

Title	Heat effects on horizontal structural support members		
Test Type	Custom		
Lab Number	ATFFRL040002		
Test dates	8/10/04, 8/11/04	**No. Tests**	4

Thermocouples

Thermocouples are temperature measurement sensors that consist of two dissimilar metals joined at one end (a junction) that produces a small thermo-electrical voltage when the wire is heated. The change in voltage is interpreted as a change in temperature [1]. There are many configurations of thermocouples which affect the temperature range, ruggedness, and response time. The information required to identify these factors for the thermocouples that were used during the experiment(s) conducted for this test series is provided in the "Thermocouple Measurement Description" table. Thermocouples used during this test series were used in accordance with the method defined in FRL laboratory instruction "LI001 Thermocouple" [2].

The following table provides a description of the instrumentation used to collect the temperature measurements during the experiments. The "Description" column describes the location of the temperature measurement. The "Thermocouple Type" describes the characteristics of the thermocouple used.

Table 1. Thermocouple Measurement Description

Description	Thermocouple type
TC 1	Type K, Glass Ins.,24 ga wire
TC 2	Type K, Glass Ins.,24 ga wire
TC 3	Type K, Glass Ins.,24 ga wire

Heat Flux Transducers

A heat flux transducer is a device that measures the rate of absorbed incident energy, and expresses it on a per unit area basis. The operating principle of the Schmidt-Boelter heat flux transducer(s) used during this test series is based on one-dimensional heat conduction through a solid. Temperature sensors are placed on a thin, thermally conductive sensor element, and applying heat establishes a temperature gradient across the element. The heat flux is proportional to the temperature difference across the element according to Fourier's Law [3].

There are many configurations of heat flux transducers which affect range, size, mode and sensitivity. The information required to identify these factors for the heat flux transducer(s) that were used during the experiment(s) conducted for this test series is

provided in the "Heat Flux Measurement Description" table. Heat flux transducers were used in accordance with the method defined in FRL laboratory instruction "LI002 Heat Flux Transducer" [4].

The following table provides a description of the transducer used to collect heat flux measurements during the experiment(s). The "Description" column typically describes the location of the heat flux transducer. The "Path Length" is the measurement from the surface of the transducer to a specified location. This is typically the distance from the face of the transducer to the centerline of the fire or to the surface of a power source. Heat flux mode indicates whether the total heat flux was measured or just the radiation fraction.

Table 2. Heat Flux Measurement Description

Description	Path Length (m)	Heat Flux Mode
Heat Flux 1	0.3	Total
Heat Flux 2	0.3	Total
Heat Flux 1	0.3	Total
Heat Flux 2	0.3	Total

Experiment Photographs

Digital Cameras are used within the FRL to record digital still photographs during experiments. Digital Cameras used during this test series were used in accordance with the method defined in FRL Laboratory Instruction "LI003 Digital Cameras" [5].

Results for Test 3 (ID 650)

The following table provides a summary of the temperature results. The "Initial" column provides the measured temperature at the beginning of the test. The maximum temperature recorded during the test is provided in the "Max" column. The remaining columns provide the calculated maximum average temperatures.

Table 3. Temperature Value Result Summary

Description	Initial (C)	Max (C)	30 second maximum average (C)	60 second maximum average (C)	300 second maximum average (C)	600 second maximum average (C)
TC 1	28	100	82	76	69	0
TC 2	32	208	197	190	163	0
TC 3	30	263	244	232	196	0

The following chart(s) present a time-dependent representation of the instantaneous temperatures measured during the experiment.

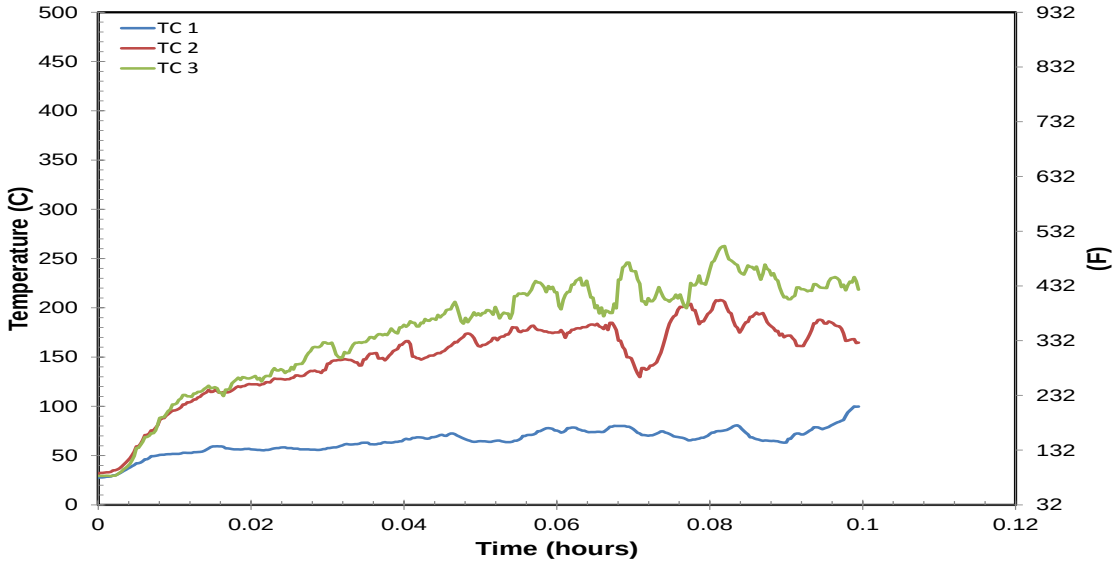

Figure 1. Temperature

The following table provides a summary of the heat flux results. The "Description" column typically describes the location of the heat flux transducer. The time at which the heat flux first changes by a pre-determined amount is provided in the "Time of Initial Change" column. The pre-determined amount of change in heat flux is provided in the "Initial Change Amount" column. The maximum heat flux recorded during the test is provided in the "Maximum" column. The "Maximum Average" columns are calculated over four pre-determined time spans.

Table 4. Heat Flux Result Summary

Description	Time of Initial Change (s)	Initial Change Value (kW/m²)	Maximum (kW/m²)	30 second maximum average (kW/m²)	60 second maximum average (kW/m²)	300 second maximum average (kW/m²)	600 second maximum average (kW/m²)
Heat Flux 1	0	5	5.5	5	4.8	4.3	0
Heat Flux 2	0	5	9.1	7.7	7.5	6.2	0

The following chart shows a time dependent representation of the instantaneous heat flux measured during the experiment.

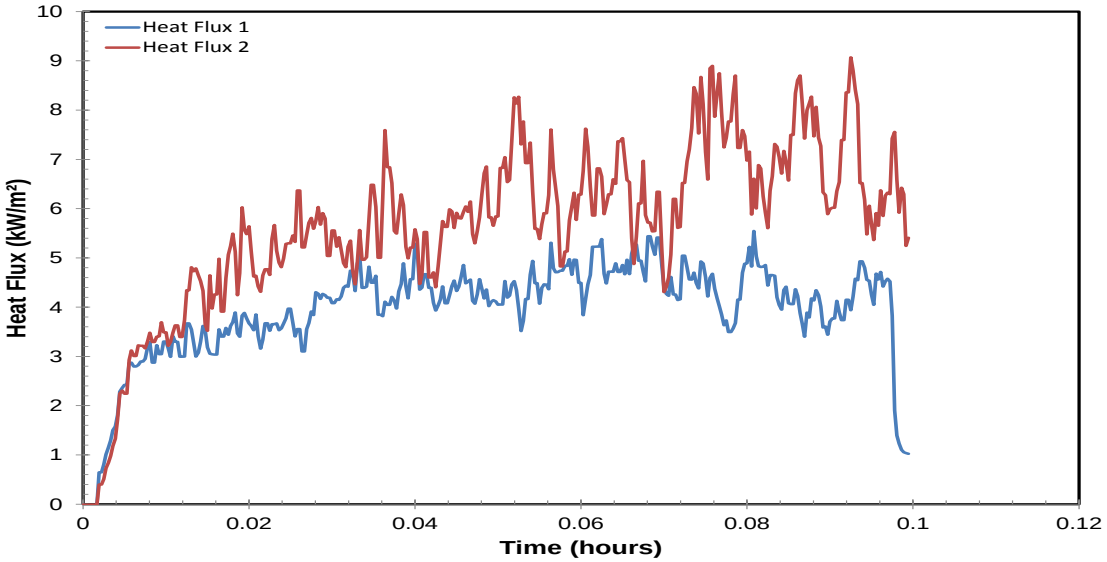

Figure 2. Heat Flux

The following figures show all of the still photographs uploaded into the FireTOSS system. The caption below each figure provides the picture's filename as well as any description and elapsed test time associated with the picture.

Figure 3. three,
POST,
2004081789693

Results for Test 7 (ID 655)

The following table provides a summary of the temperature results. The "Initial" column provides the measured temperature at the beginning of the test. The maximum temperature recorded during the test is provided in the "Max" column. The remaining columns provide the calculated maximum average temperatures.

Table 5. Temperature Value Result Summary

Description	Initial (C)	Max (C)	30 second maximum average (C)	60 second maximum average (C)	300 second maximum average (C)	600 second maximum average (C)
TC 1	28	332	281	266	242	236
TC 2	27	85	79	75	67	65
TC 3	26	238	228	216	180	170

The following chart(s) present a time-dependent representation of the instantaneous temperatures measured during the experiment.

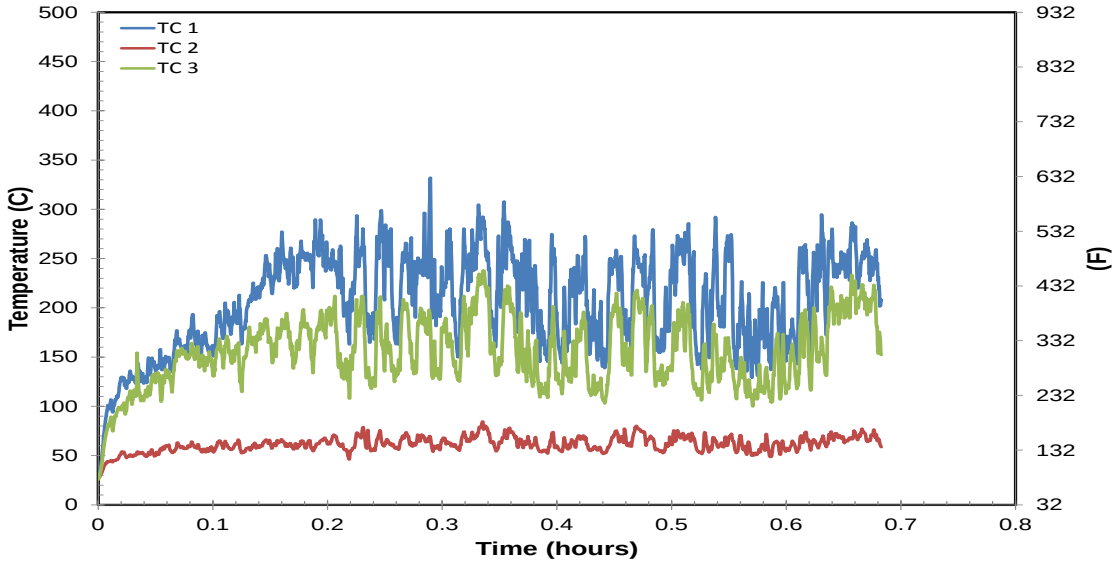

Figure 4. Temperature

The following table provides a summary of the heat flux results. The "Description" column typically describes the location of the heat flux transducer. The time at which the heat flux first changes by a pre-determined amount is provided in the "Time of Initial Change" column. The pre-determined amount of change in heat flux is provided in the "Initial Change Amount" column. The maximum heat flux recorded during the test is provided in the "Maximum" column. The "Maximum Average" columns are calculated over four pre-determined time spans.

Table 6. Heat Flux Result Summary

Description	Time of Initial Change (s)	Initial Change Value (kW/m²)	Maximum (kW/m²)	30 second maximum average (kW/m²)	60 second maximum average (kW/m²)	300 second maximum average (kW/m²)	600 second maximum average (kW/m²)
Heat Flux 1	0	5	8.3	6.6	6.4	6.1	5.9
Heat Flux 2	0	5	8.6	6.1	6	5.7	5.6

The following chart shows a time dependent representation of the instantaneous heat flux measured during the experiment.

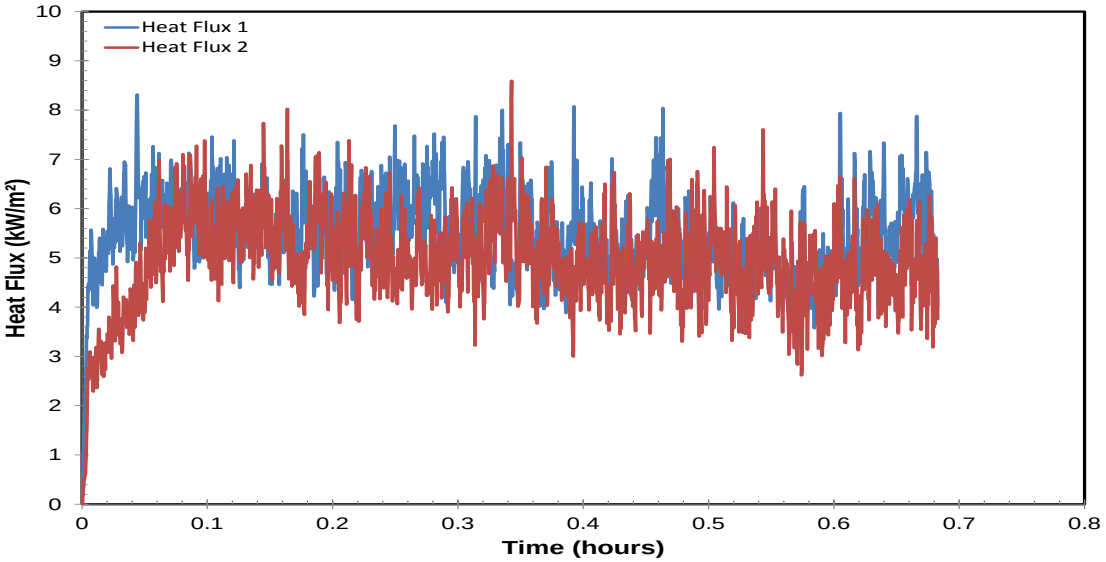

Figure 5. Heat Flux

The following figures show all of the still photographs uploaded into the FireTOSS system. The caption below each figure provides the picture's filename as well as any description and elapsed test time associated with the picture.

Figure 6. Fire Exposure side, 70, 200408111725723

Figure 7. Unexposed side, 353, 200408111725208

Figure 8. Unexplosed side, 358, 200408111725438

Figure 9. Fire Exposure side, 490, 200408111725628

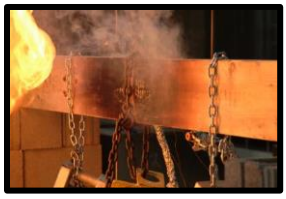

Figure 10. Fire Exposure side, 500, 200408111725149

Figure 11. Fire Exposure side, 724, 200408111725500

Figure 12. Fire Exposure side, 729, 200408111725680

Figure 13. 737, 200408111725860

Figure 14. 1,182, 200408111725171

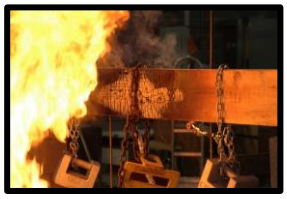

Figure 15. 1,187, 200408111725501

Figure 16. 2,127, 200408111725681

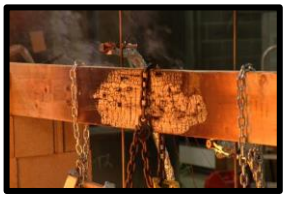

Figure 17. 2,132, 200408111725862

Figure 18. 2,139, 200408111725152

Figure 19. 2,161, 200408111725433

Figure 20. POST, 200408111725264

Figure 21. Post test damage, POST, 200408111725444

Figure 22. Post test damage, POST, 200408111725825

Figure 23. Post test damage, PRE, 200408121121477

Results for Test 8 (ID 656)

The following table provides a summary of the temperature results. The "Initial" column provides the measured temperature at the beginning of the test. The maximum temperature recorded during the test is provided in the "Max" column. The remaining columns provide the calculated maximum average temperatures.

Table 7. Temperature Value Result Summary

Description	Initial (C)	Max (C)	30 second maximum average (C)	60 second maximum average (C)	300 second maximum average (C)	600 second maximum average (C)
TC 1	29	153	127	118	108	106
TC 2	26	880	743	714	538	398
TC 3	27	949	866	776	345	324

The following chart(s) present a time-dependent representation of the instantaneous temperatures measured during the experiment.

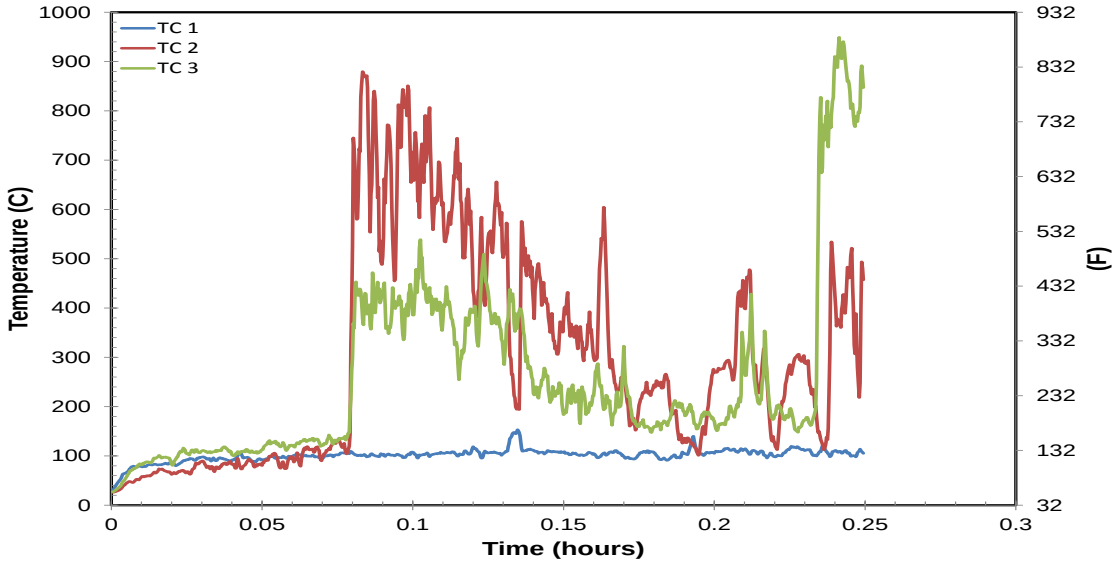

Figure 24. Temperature

The following table provides a summary of the heat flux results. The "Description" column typically describes the location of the heat flux transducer. The time at which the heat flux first changes by a pre-determined amount is provided in the "Time of Initial Change" column. The pre-determined amount of change in heat flux is provided in the "Initial Change Amount" column. The maximum heat flux recorded during the test is provided in the "Maximum" column. The "Maximum Average" columns are calculated over four pre-determined time spans.

Table 8. Heat Flux Result Summary

Description	Time of Initial Change (s)	Initial Change Value (kW/m²)	Maximum (kW/m²)	30 second maximum average (kW/m²)	60 second maximum average (kW/m²)	300 second maximum average (kW/m²)	600 second maximum average (kW/m²)
Heat Flux 1	0	5	6.2	5.2	4.9	4.7	4.5
Heat Flux 2	883	5	32767	1108	558.1	117.1	62.6

The following table shows which heat flux transducers(s) were taken out of service during the experiment(s). The "Description" column typically describes the location of the heat flux transducer. If the heat flux measurement has to be discontinued during a test the "Out of Service Time" and "Out of Service Reason" columns report the test time and reason why the heat flux measurement was removed, respectively

Table 9. Out of Service Times

Description	Serial number	Out of service time (s)
Heat Flux 1	122797	800
Heat Flux 2	122793	800

The following chart shows a time dependent representation of the instantaneous heat flux measured during the experiment.

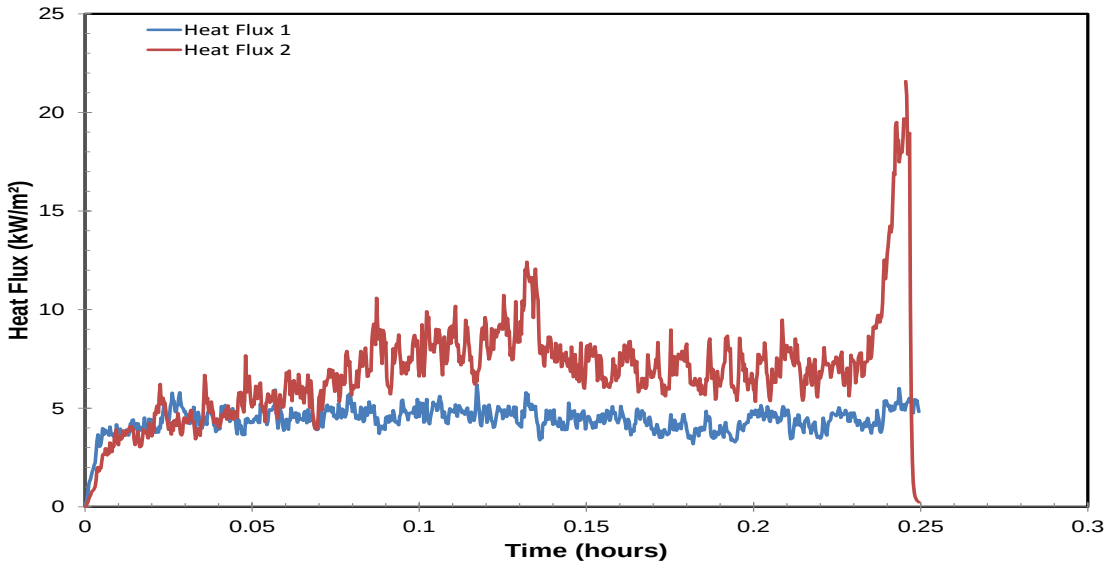

Figure 25. Heat Flux

The following figures show all of the still photographs uploaded into the FireTOSS system. The caption below each figure provides the picture's filename as well as any description and elapsed test time associated with the picture.

Figure 26. 142, 20040811173048

Figure 27. 254, 200408111730678

Figure 28. 258, 20040811173089

Figure 29. 310, 200408111730471

Figure 30. 395, 200408111730142

Figure 31. 403, 200408111730723

Figure 32. 571, 200408111730265

Figure 33. 581, 200408111730886

Figure 34. 799, 200408111730287

Figure 35. 808, 200408111730998

Figure 36. 854, 200408111730598

Figure 37. 862, 200408111730179

Figure 38. POST, 200408111730520

Figure 39. POST, 200408111730241

Figure 40. POST, 200408111730832

Figure 41. POST, 200408111730933

Results for Test 10 (ID 657)

The following table provides a summary of the heat flux results. The "Description" column typically describes the location of the heat flux transducer. The time at which the heat flux first changes by a pre-determined amount is provided in the "Time of Initial Change" column. The pre-determined amount of change in heat flux is provided in the "Initial Change Amount" column. The maximum heat flux recorded during the test is provided in the "Maximum" column. The "Maximum Average" columns are calculated over four pre-determined time spans.

Table 10. Heat Flux Result Summary

Description	Time of Initial Change (s)	Initial Change Value (kW/m²)	Maximum (kW/m²)	30 second maximum average (kW/m²)	60 second maximum average (kW/m²)	300 second maximum average (kW/m²)	600 second maximum average (kW/m²)
Heat Flux 1	416	5	13.7	9.7	9.3	8.2	0
Heat Flux 2	416	5	11.4	8.9	8.7	7.5	0

The following table shows which heat flux transducers(s) were taken out of service during the experiment(s). The "Description" column typically describes the location of the heat flux transducer. If the heat flux measurement has to be discontinued during a test the "Out of Service Time" and "Out of Service Reason" columns report the test time and reason why the heat flux measurement was removed, respectively

Table 11. Out of Service Times

Description	Serial number	Out of service time (s)
Heat Flux 2	122793	850

The following chart shows a time dependent representation of the instantaneous heat flux measured during the experiment.

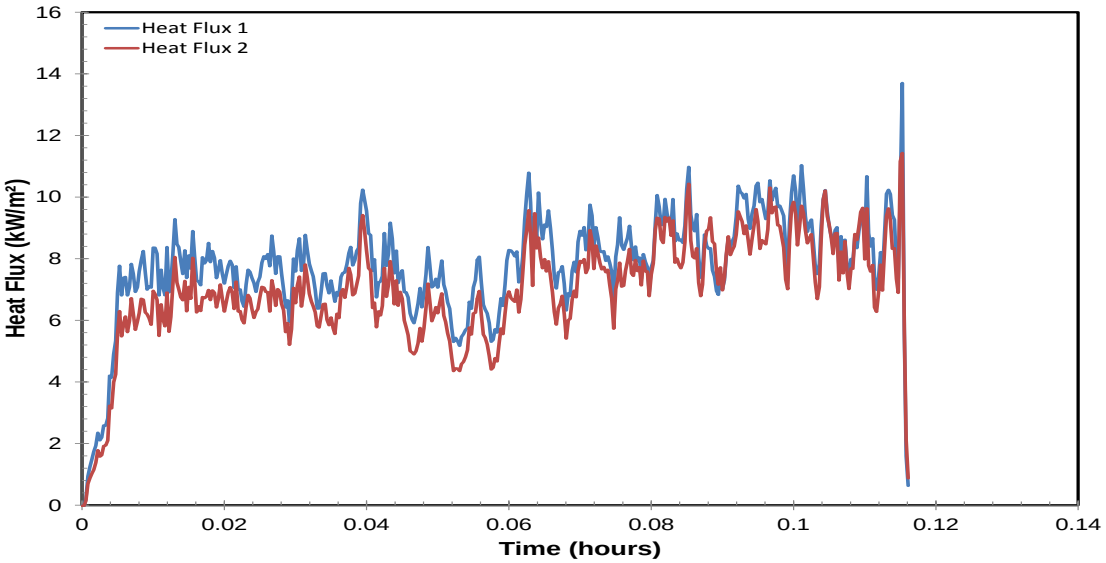

Figure 42. Heat Flux

References

1. The Temperature Handbook, 2nd edition, Omega Engineering, Stamford, CT, 2000.
2. Laboratory Instruction LI001 - Thermocouple, Bureau of Alcohol, Tobacco, Firearms and Explosives – Fire Research Laboratory, Beltsville, MD.
3. Barnes, A., "Heat Flux Sensors Part 1: Theory," Sensors, January 1999.
4. Laboratory Instruction LI002 - Heat Flux Transducer, Bureau of Alcohol, Tobacco, Firearms and Explosives - Fire Research Laboratory, Beltsville, MD.
5. Laboratory Instruction LI003 - Digital Cameras, Bureau of Alcohol, Tobacco, Firearms and Explosives - Fire Research Laboratory, Beltsville, MD